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Weight and Body Composition Changes during and after Adjuvant Chemotherapy in Women with Breast Cancer

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Uncontrolled trials have reported significant weight gain in women with breast cancer during treatment with adjuvant chemotherapy. We prospectively evaluated body composition before (visit 1), immediately after (visit 2), and 6 months after (visit 3) chemotherapy in 20 women with stages I-IIIA breast cancer [body mass index (BMI): 24.1 ± 3.9 kg/m^2]. We compared their weight change to 51 age- and BMI-matched healthy controls (BMI: 25.5 ± 3.8 kg/m^2).

In women with breast cancer, there was no weight change from visit 1–2, or from visit 1–3, but weight increased from visit 2–3 (+1.09 ± 2.46 kg; $P = 0.05$). Weight change was not different from controls during either interval.

In the breast cancer group, the percentage of body fat assessed by air displacement plethysmography increased, and fat-free mass decreased from visit 1–2 (+2.3 ± 4% and −2.2 ± 4%; $P = 0.02$) and from visit 1–3 (+4.0 ± 6% and −3.8 ± 6%; $P = 0.01$). By dual energy x-ray absorptiometry, the percentage of body fat increased from visit 2–3 (+0.9 ± 1.6%; $P = 0.02$). Bone mineral content decreased from visit 2–3 (−0.02 ± 0.04 kg; $P = 0.02$) and from visit 1–3 (−0.04 ± 0.06 kg; $P = 0.005$). By computed tomography, the visceral adipose to sc adipose tissue ratio decreased from visit 1–3 (−0.02 ± 0.05 ml; $P = 0.02$).

We conclude that, compared with controls, women with breast cancer receiving modern adjuvant chemotherapy regimens show no significant changes in weight during the first year of their treatment. They do, however, appear to undergo unfavorable changes in body composition. (*J Clin Endocrinol Metab* 89: 2248–2253, 2004)

WEIGHT GAIN AFTER chemotherapy for breast cancer is a common and clinically well-appreciated phenomenon first reported in the 1970s (1–5). A number of uncontrolled trials have suggested that significant increases in weight occur in 50–96% of all early stage breast cancer patients during treatment with adjuvant chemotherapy, with the median gain in weight ranging from 2.5–6.2 kg over treatment and follow-up periods up to 1 yr (2–4, 6). Adjuvant chemotherapy has been found to be a strong clinical predictor of weight gain in women with early stage breast cancer that is independent of age at diagnosis, nodal status, body mass index (BMI) at diagnosis, and reported caloric intake (7).

The degree of weight gain in response to chemotherapy appears dependent on the chemotherapeutic agents used. Women treated with cyclophosphamide, methotrexate, and 5-fluorouracil (CMF) are reported to have significant gains in both body weight and fat mass during treatment (8–10). Other studies using predominantly doxorubicin and cyclophosphamide (AC) (1, 11) find no weight gain during chemotherapy but demonstrate loss of lean body mass that results in an increased percentage of body fat (11).

Most previous studies of weight change in women with breast cancer have been limited by three factors. First, most lacked appropriate, contemporaneously studied controls, making it unclear whether the reported weight gain in breast cancer patients receiving adjuvant chemotherapy differs from the usual weight gain of healthy subjects [approximately 0.4 kg/yr for premenopausal (12) and 0.54 kg/yr for postmenopausal women (13)]. Second, the majority of reported studies focused on weight changes exclusively during the treatment period, with few studies examining weight changes after chemotherapy (2, 7, 14–17). Third, many studies relied on retrospective chart review to determine body weight (3, 14, 15, 18) and few gathered weight and weight-related data before the onset of chemotherapy.

To address these limitations and in an attempt to clarify how weight and body composition change in women receiving modern adjuvant chemotherapy regimens, we prospectively evaluated body weight and body composition of women with breast cancer before adjuvant chemotherapy, immediately after treatment, and 6 months post completion of the adjuvant chemotherapy and compared their weight change to that of an age- and BMI-matched healthy control group of women.

Abbreviations: AC, Doxorubicin and cyclophosphamide; ADP, air displacement plethysmography; BIA, bioelectrical impedance analysis; BMC, bone mineral content; BMI, body mass index; CI, confidence interval; CMF, cyclophosphamide, methotrexate, and 5-fluorouracil; DXA, dual energy x-ray absorptiometry; IAT, intraabdominal adipose tissue; SAT, sc abdominal adipose tissue.

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Subjects and Methods

Women with breast cancer

A convenience sample of 26 women with breast cancer were recruited from the Bethesda National Naval Medical Center (Bethesda, MD), Walter Reed Army Medical Center (Washington, DC), and Suburban Hospital (Bethesda, MD) between July 1999 and January 2001. Women were included in the study if they had histologically confirmed primary breast cancer (stages I, II, and operable IIIA) and planned to receive chemotherapy. Women between the ages 18 and 80 who were either premenopausal (defined by regular menses and no history of natural or surgical menopause) or postmenopausal (defined by no periods for >1 yr or a history of surgical menopause) were included. Patients with breast cancer were excluded from the study if they did not require chemotherapy or were already receiving neoadjuvant chemotherapy. Other exclusions included patients receiving alternative therapies alone, women with recurrent breast cancer, those with distant metastases or stages IIIB and above, women participating in or planning to participate in dietary and/or exercise weight loss programs, and patients with a history of diabetes mellitus or untreated hypo- or hyperthyroidism. Once enrolled, patients were excluded from the study if they had disease progression, developed medical disorders such as heart and lung disease or diabetes, were noncompliant with the baseline procedures, or began use of antidepressants or other medications known to promote weight gain or loss. The study was approved by the Institutional Review Board of the National Cancer Institute, National Institutes of Health, and signed consent was obtained from each subject.

Study design for women with breast cancer

Subjects with breast cancer were prospectively evaluated on three occasions: at baseline (approximately 2–4 wk after breast surgery and immediately preceding initiation of chemotherapy), at 2 wk after their final chemotherapy cycle, and at 6 months after their final chemotherapy cycle.

During each visit, subjects were weighed to the nearest 0.01 kg using an electronic scale (Life Measurement Instruments, Concord, CA) that was calibrated against a standard weight before each measurement. Subjects were weighed in the morning after an overnight fast wearing undergarments and hospital gowns without shoes. Height was measured to the nearest 1 mm with a stadiometer (Holtain, Crymych, UK) that was calibrated against a standard height before each use. BMI was calculated as weight (kilograms) divided by height (meters) squared.

At each visit, a complete history was taken, and a physical examination was performed. Data regarding each subject's chemotherapy regimen, radiation exposure, and use of glucocorticoids were obtained retrospectively, by patient report and/or from each patient's oncologist (n = 18 for glucocorticoid use). Minimal waist (measured at the narrowest part of the trunk, n = 17), abdominal waist (measured just above the iliac crest, n = 17), and hip circumferences (n = 19) were obtained by a registered dietitian in duplicate as recommended (19) with additional measurements obtained in the case of values differing by more than 1 cm. Two subjects underwent breast reconstruction surgery using abdominal fat grafts; therefore, their minimal and abdominal waist circumferences were not used. Total body fat, fat-free mass, and lean soft tissue (percentage and kilograms) and bone mineral content [(BMC), kilograms] were assessed using dual energy x-ray absorptiometry [(DXA), Hologic QDR-4500A, Bedford, MA]. Total body minus upper limb fat and fat-free mass were also calculated to eliminate any effect arm lymphedema secondary to mastectomy may have had. Percentage of body fat, fat-free mass, and lean soft tissue were transformed by arcsine square root before analysis. Body composition was also assessed using air displacement plethysmography [(ADP), Life Measurement Instruments, Concord, CA, software version 1.69] using the Siri equation according to the manufacturer's directions and procedures as previously described (20), and bioelectrical impedance analysis (BIA) was measured using the Bioelectrical Body Composition Analyzer (model Quantum II, RJL Systems, Detroit, MI) as described elsewhere (21). BIA percentage of body fat was calculated using Weight Manager Software (version 2.2, RJL Systems). Computed tomography at L4/L5 was obtained in 17 subjects at baseline and 6 months after the end of chemotherapy to measure total abdominal adipose tissue, sc abdominal adipose tissue (SAT), and intraabdominal adipose tissue (IAT) as previously described (22). The IAT/SAT ratio was calculated. Measurements of IAT and SAT were log-transformed before analysis.

Control women

Fifty-one women from a prospective longitudinal study of body weight in healthy adults (12) were used as controls. These women had no known health concerns, were taking no medications, and were recruited contemporaneously to study subjects with breast cancer. Control women had weight and height measurements as outlined above at 6- to 8-wk intervals over a 1-yr period. The subjects in the control group were selected to match baseline age, race, weight, and BMI of the women with breast cancer. Weight measurements from similar time intervals as for the breast cancer group were used for comparisons. No body composition measurements other than weight and height were obtained from control subjects.

Analysis

Because the time interval between weight measurements for each subject was not identical, weight change data were expressed as weight change per day. Data were log-transformed as required to achieve homoscedasticity. Student's *t* tests were used to compare weight change per day between groups at two intervals: interval 1 was defined for the breast cancer group as the period between their baseline assessment and the visit immediately after completion of chemotherapy; interval 2 was defined for the breast cancer group as the period between completion of chemotherapy and their study visit approximately 6 months later. For control subjects, intervals 1 and 2 consisted of two consecutive periods of measurement that corresponded best to the time intervals of the women who underwent chemotherapy.

Regression analyses were used to examine for relationships between gain in weight or fat mass in the women with breast cancer and age, baseline BMI, baseline menopausal status, radiation, tamoxifen, or glucocorticoid use. In these analyses, weight gain or fat mass were the dependent variables and the other factors served as independent variables. StatView for Windows version 5.0.1 (SAS Institute Inc., Cary, NC) was used to perform Student's *t* tests and regression analyses.

Results

All healthy control women completed the study. Six women with breast cancer withdrew from the study after either the baseline (n = 2) or postchemotherapy visit (n = 4). Reasons included insufficient time for participation/inconvenience (three women), pregnancy (two women), and chemotherapy-induced cardiomyopathy (one woman).

Of the 20 evaluable subjects with breast cancer, 70% had stage II breast cancer, 20% had stage I breast cancer, and 10% had stage IIIA breast cancer. Forty percent of women underwent mastectomy, and 65% had cancer detected in 1 or more lymph nodes. The most frequently used chemotherapy regimens were AC alone (40%) or in combination with paclitaxel (50%). Docetaxelin in combination with AC was given to 10% of subjects. Women with breast cancer were treated with chemotherapy for an average of 113 ± 57 d. After chemotherapy, 75% of women received tamoxifen, and 75% were treated with radiation therapy (Table 1). Of 18 women with available glucocorticoid data, all 18 received the treatment, most commonly as a premedication to chemotherapy. There were no significant differences between the breast cancer and control groups with regard to race, baseline age, weight, or BMI (Table 1).

At 2 wk post chemotherapy, 30% of the participants reported an increase, 25% reported a decrease, and 45% reported no change in appetite. Seventy-four percent of women reported fatigue, 26% reduced their activity level, and 11%

TABLE 1. Characteristics of study participants

	Women with breast cancer (n = 20)	Control women (n = 51)	*P*
Age (yr)	48.2 ± 8.8	46.2 ± 9.1	0.12
Race			
Caucasian (%)	80	67	
African-American (%)	20	29	0.41
Other (%)	0	4	
Premenopausal (%)	50	69	0.13
BMI at baseline (kg/m^2)	24.1 ± 3.9	25.5 ± 3.8	0.16
Weight at baseline (kg)	65.8 ± 13	68.6 ± 10.1	0.33
Weight change interval 1 (g/d)	−8 ± 29	+1.4 ± 14	0.15
Weight change interval 2 (g/d)	+6 ± 14	+2.8 ± 11	0.36
Net weight change over study (g/d)	+0.1 ± 16	+2.1 ± 8.6	0.79
Days between visits 1–2	145.4 ± 49.9	156.5 ± 10.1	0.13
Days between visits 2–3	174.9 ± 16.7	196.6 ± 11.5	<0.01
Days between visits 1–3	320.2 ± 46.4	353 ± 12.7	<0.01

All values are expressed as mean ± SD unless otherwise specified; *P* values based on Student's *t* tests. Interval 1 was defined for the breast cancer treatment group as the period between their baseline assessment (visit 1) and their visit immediately after completion of chemotherapy (visit 2); interval 2 was defined for the breast cancer treatment group as the period between completion of chemotherapy (visit 2) and their study visit approximately 6 months later (visit 3). For control subjects, intervals 1 and 2 consisted of the two consecutive periods of measurement that corresponded best to the time intervals of the women who underwent chemotherapy.

reduced their employment activity. At 6 months post chemotherapy, 25% reported an increase, 20% reported a decrease, and 50% reported no change in appetite from prechemotherapy levels. Seventy-five percent of women reported fatigue, 15% reduced their physical activity, and 15% reduced their employment activity.

Comparison of weight and BMI changes in women with breast cancer and control women

Among the women with breast cancer, 12 women lost weight (range: −0.2 to −9.2 kg), and eight women gained weight (range: +0.2 to +7.0 kg) during interval 1. The mean weight during this interval showed a small, nonsignificant decline (65.8 ± 13.0 kg to 64.9 ± 12.3 kg; −0.83 ± 3.62 kg; $P = 0.4$). In the control group, 27 women lost weight during interval 1 (range: −0.13 to −5.35 kg), and 24 women gained weight (range: +0.01 to +4.87 kg). Control women's mean weight during interval 1 showed a small and nonsignificant increase (68.6 ± 10.1 kg to 68.8 ± 10.7 kg; +0.17 ± 2.16 kg; $P = 0.6$). During interval 2, seven women with breast cancer lost weight (range: −0.5 to −3.4 kg), 12 gained weight (range: +0.2 to +5.4 kg), and one had no weight change, and the mean weight during this interval increased significantly (64.9 ± 12.3 kg to 66 ± 12.7 kg; +1.09 ± 2.46 kg; $P = 0.05$). In the control group, 20 women lost weight during interval 2 (range: −0.14 to −4.09 kg), 31 gained weight (range: +0.06 to +5.03 kg), and mean weight increased (68.8 ± 10.7 kg to 69.3 ± 11.0 kg; +0.54 ± 2.09 kg; $P = 0.07$). Weight change per day (Table 1 and Fig. 1) was not significantly different between the two groups during either interval. Within the breast cancer group, weight change per day during interval 2 (+6 ± 14 g/d) was significantly greater than during interval 1 (−8 ± 29 g/d; $P = 0.04$). Over the entire 10.5 months of study, the women with breast cancer had a small net weight gain of 0.27 ± 4.6 kg (+0.1 ± 16 g/d), which was not significantly different from controls (0.7 ± 3.1 kg, $P = 0.85$, and +2.1 ± 8.6 g/d; $P = 0.79$, respectively).

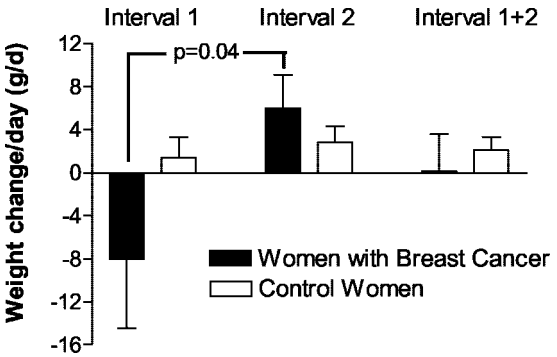

FIG. 1. Weight change per day in women with breast cancer and control women over the course of the study. Intervals 1 and 2 are defined in Table 1. There were no significant differences in weight change per day between women with breast cancer and control women during any interval. However, for women with breast cancer only, weight change per day was significantly greater during interval 2 than interval 1 ($P = 0.04$).

Body composition of women with breast cancer (Table 2)

Among women with breast cancer, mean minimal waist and mean hip circumference increased significantly during interval 2 (Table 2; $P = 0.05$). Mean abdominal waist circumference did not change. BIA percentage of body fat showed a downward trend at the end of interval 1 (−1.2 ± 3%; $P = 0.09$) and a significant increase at the end of interval 2 (+1.7 ± 3%; $P = 0.02$). From baseline to the end of the study, however, there was no significant net difference in percentage of body fat by BIA. ADP showed a percentage of body fat increase over interval 1 (+2.3 ± 4%; $P = 0.02$) and a continued significant increase 6 months post chemotherapy (+3.8 ± 6%; $P = 0.01$). By ADP, the percentage of fat-free mass decreased by −2.2 ± 4% ($P = 0.03$) over interval 1 and continued to decrease by −3.8 ± 6% ($P = 0.01$) at 6 months post chemotherapy. There was no significant change in fat mass or fat-free mass during interval 2 ($P = 0.16$). DXA revealed no significant change in total body fat (kilograms or percentage) at the end of interval 1 but did show a significant

TABLE 2. Changes in body composition in women with breast cancer

	Visit 1 (Prechemotherapy)	Visit 2 (2 wk after completion of chemotherapy)	Visit 3 (6 months after completion of chemotherapy)
Minimal waist circumference (cm)	75.5 ± 11.5	76.0 ± 8.8	77.6 ± 8.9[b]
Abdominal waist circumference (cm)	85.2 ± 9.3	86.9 ± 10.4	86.1 ± 7.4
Hip circumference (cm)	101.4 ± 9.0	101.1 ± 8.2	102.3 ± 7.7[b]
Body fat by BIA (%)	30.8 ± 8.0	29.7 ± 7.0	31.4 ± 7.0[b]
Body fat by ADP (%)	33.8 ± 9.0	36.3 ± 8.0[a]	37.9 ± 8.0[a]
Body fat by ADP (kg)	22.8 ± 9.5	23.9 ± 8.8[a]	25.3 ± 8.7[a]
Fat-free mass by ADP (%)	66.2 ± 9.0	63.9 ± 8.0[a]	62.1 ± 8.0[a]
Fat-free mass by ADP (kg)	42.4 ± 6.4	41.0 ± 6.72[a]	40.6 ± 7.21[a]
DXA			
Total body fat (kg)	22.9 ± 8.5	22.5 ± 7.4	23.6 ± 8.2[b]
Total body fat (%)	33.7 ± 7.0	33.6 ± 6.2	34.6 ± 6.5[b]
Bone mineral content (kg)	2.21 ± 0.36	2.19 ± 0.34	2.17 ± 0.35[a,b]
Computed tomography scan (L 4/5)			
SAT (cc)	243.5 ± 110.5	—	252.8 ± 110.9
IAT (cc)	64.0 ± 30.6	—	62.3 ± 31.2
IAT/SAT ratio	0.29 ± 0.13	—	0.26 ± 0.13[a]

All values are expressed as mean ± SD unless otherwise specified. *P* values based on Student's *t* tests.
[a] $P < 0.05$ *vs.* visit 1.
[b] $P < 0.05$ *vs.* visit 2.

increase during interval 2 (+0.9 ± 1.6%; $P = 0.02$). DXA results remained significant even when the upper limbs were excluded (data not shown). There were no significant changes in fat-free mass or lean soft tissue by DXA. Overall, there was a significant net decline in BMC during the study (−40 ± 60 g; $P = 0.005$). Total BMC did not decline significantly during interval 1 ($P = 0.2$) but subsequently decreased significantly over interval 2 (Table 2; 20 ± 40 g; $P = 0.02$). The decrease in BMC occurred irrespective of whether women were premenopausal or postmenopausal before receiving adjuvant chemotherapy. Abdominal computed tomography showed a nonsignificant increase in SAT (Table 2; $P = 0.38$) and a nonsignificant decrease in IAT at L4/5 (Table 2; $P = 0.65$) during the study; however, the ratio of IAT to SAT decreased significantly (−0.02 ± 0.05 ml; $P = 0.02$).

Weight and baseline menopausal status

Half of the women with breast cancer in the study were premenopausal before chemotherapy and all but one became amenorrheic by 6 months post chemotherapy. Menopausal status before chemotherapy was significantly associated with weight gain during interval 2. Women who were premenopausal before chemotherapy gained significantly more weight during interval 2 than did women who were postmenopausal at baseline (+2.43 ± 2.1 kg *vs.* −0.24 ± 2.1 kg; $P = 0.01$) independent of baseline BMI. There was no significant association between menopausal status and weight change over interval 1, and no associations between weight change or body fat (by DXA or BIA percentage) and radiation therapy, tamoxifen therapy, glucocorticoid use, fatigue, nausea, change in activity level, or appetite change at either interval 1 or 2.

Discussion

We found no significant differences in weight change between women treated with adjuvant chemotherapy for breast cancer and age- and BMI-matched control women. Although control women gained weight steadily, women with breast cancer had a small, nonsignificant initial weight loss during chemotherapy that was followed by weight regain at 6 months post chemotherapy completion. Although no significant net weight change in women with breast cancer was seen over the course of the study (10.5-month follow-up interval), there appeared to be increases in total body fat and decreases in fat-free mass and lean soft tissue.

The reason for the lack of weight gain during chemotherapy, as has been typically seen in other studies, is unclear. It is possible that the chemotherapy used in our study (AC with or without paclitaxel) in combination with the relatively shorter duration of chemotherapy administration played a role. Two prior small studies (11, 16) using primarily AC also found no weight change over the course of treatment. Demark-Wahnefried *et al.* (16) studied a group of 20 premenopausal women with stage I or II breast cancer receiving primarily AC over 15 wk, and found no weight change from baseline throughout the treatment. Kutynec *et al.* (11) compared weight in 18 women receiving either AC adjuvant chemotherapy (n = 8) or radiation therapy (n = 10) in a prospective 12-wk study and found no weight gain in either group. In our study, 90% of patients received AC (50% also received paclitaxel) for approximately 16 wk. Multiagent chemotherapeutic regimens of long durations have been associated with greater weight gains (3). Studies of women treated with CMF chemotherapy for their breast cancer did report weight gain during chemotherapy (8–10). However, a recent prospective study (10) of 100 patients who had completed six cycles of either fluorouracil, epirubicin, and cyclophosphamide or CMF chemotherapy found no statistically significant association between weight gain and chemotherapy regimen (10). Chemotherapy regimens that include glucocorticoids have been associated in some (3, 14), but not all (10), series with greater weight gains. In our study, the majority of subjects were given short-term glucocorticoids pretreatment for nausea prophylaxis, with many receiving them only during their first or second cycle of chemotherapy. This limited use of glucocorticoids may explain why no association between its use and weight gain was seen. Finally, as with any prospective study design, it is

possible that there was selection bias in the patients recruited; *e.g.* those patients who elected to be in the study were more concerned about their weight and perhaps more likely to make efforts to maintain it. Alternatively, the informed consent process may conceivably have caused subjects to pay more attention to their weight.

After chemotherapy (interval 2), subjects with breast cancer did tend to gain weight; however, this weight change was not significantly different from that of the control subjects, even after controlling for the number of days between patient visits. Along with the gain in weight, mean hip and minimal waist circumferences, as well as percentage of body fat by BIA and DXA, increased. It is possible that with longer follow-up or a greater sample size, weight gain in the women with breast cancer would differ significantly from controls. In the few studies that have examined long-term weight changes in women with breast cancer after chemotherapy, weight gain has been observed. Goodwin *et al.* (7) compared weight gain in a cohort of 535 women with breast cancer at 1 yr after diagnosis and surgery. Those who received approximately 6 months of adjunctive chemotherapy (various regimens) gained the most weight at 1 yr [2.5 kg; 95% confidence interval (CI): 1.8–3.2 kg] compared with those receiving tamoxifen alone (1.3 kg; 95% CI: 0.7–1.8 kg) or no adjuvant therapy (0.63 kg; 95% CI: 0.01–1.3 kg). Although the two studies by Kutynec *et al.* (11) and Demark-Wahnefried *et al.* (16) found no weight loss during chemotherapy, post-study review did find weight gain after 1 yr or more. In a study assessing psychological factors and weight gain in women with breast cancer receiving adjuvant chemotherapy, Levine *et al.* (17) found that at 2 yr of follow-up after adjuvant chemotherapy, 84% (27 of 32 women) gained an average of 6.03 kg (0.9–18.45 kg). However, each of these studies lacked a concurrent control group to allow weight change to be placed in proper perspective relative to that found in healthy women of similar age.

Other potential factors that may have contributed toward the regain in weight seen at the 6-month posttreatment visit among women with breast cancer include receipt of tamoxifen and radiation therapy. Seventy-five percent of our subjects received adjuvant tamoxifen therapy, and 75% received radiation. There are mixed reports regarding whether tamoxifen is associated with weight gain in breast cancer subjects (10, 23, 24), and we have not found any studies that focus on the effects radiation therapy may have on weight. The impact of these variables merits further examination given their almost routine use in practice.

There have been conflicting findings in the literature as to whether hyperphagia is a major contributor to weight gain in patients with breast cancer treated with chemotherapy (4, 25). At least one randomized, controlled trial has reported no benefit from dietary counseling (26). A quarter of our subjects reported increased appetite after the completion of chemotherapy; however, there was no association with degree of weight gain. Reduction in physical activity during chemotherapy has previously been found to be associated with weight gain and lower lean body mass (16). Furthermore, exercise intervention has been suggested to reduce the weight gain associated with adjuvant chemotherapy in addition to improving fatigue and functional ability (27). Despite the high prevalence of fatigue in the women of our study, surprisingly few reported decreasing their activity or employment level.

The relationship between premenopausal status before chemotherapy and weight gain post chemotherapy has been previously reported (7, 15, 28). Goodwin *et al.* (7) found the greatest weight gain in those who became menopausal during treatment (2.65 kg; 95% CI: 1.7–3.6 kg) compared with those who remained premenopausal or who were postmenopausal before therapy. The finding that women who underwent menopause during chemotherapy gained significantly more weight suggests that estrogen deficiency may play a role in the observed weight gain.

Although no significant changes in weight were found over the entire course of the study (from prechemotherapy to 6 months post chemotherapy), there were significant increases in percentage of body fat and decreases in fat-free mass by ADP and similar findings from the other body composition assessment methods. This is consistent with previous studies that have found changes in body composition during chemotherapy and/or afterward, even when no change in body weight is found (8, 9, 11). The decreases in the IAT/SAT ratio observed during the present study suggest that primarily SAT was gained.

The significant decrease in BMC in women receiving adjuvant chemotherapy is well established. Bone loss has been associated with chemotherapy-induced ovarian failure in women with breast cancer (29), but it has also been found in postmenopausal women receiving adjuvant chemotherapy for breast cancer (30), possibly due to the direct toxic effects of chemotherapy on bone. Thus, women who have undergone adjuvant chemotherapy for breast cancer may be at increased risk for osteoporosis and fractures. They may benefit from education regarding interventions such as weight-bearing exercise and/or pharmacological measures.

There are several limitations to this study. The number of subjects is relatively small. Due to the high number of subjects receiving both tamoxifen and radiation therapy, it is difficult to determine what percent of weight was gained due to adjuvant chemotherapy alone. The lack of body composition data in the control group is another limitation. Strengths of this study include the limited number of chemotherapy regimens; the presence of a healthy age- and BMI-matched control group to compare changes in weight; the collection of weight, BMI, and other relevant data before the initiation of chemotherapy; the longer-term follow-up post completion of chemotherapy; and the comprehensive anthropometric and associated assessments.

We conclude that women who received 4 months of modern adjuvant chemotherapy regimens demonstrated weight changes over a 10.5-month period that were not overtly different from the changes that occurred in a control group of women. However, body composition changed in the women with breast cancer, with increased body fat and decreased percentage of lean soft tissue and skeletal mass. Further studies delineating subsequent weight change in women with breast cancer who are followed long-term are needed to determine the physical and metabolic effects of these body composition changes.

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